Application No.: 10/664,796
Amendment Dated: June 8, 2005
Reply to the Office Action of February 8, 2005

Amendment to the claims

This listing of claims will replace all prior versions and listings of claims in the application.

Listing of claims

1. (currently amended) A particle-optical apparatus comprising a sample holder arranged for receiving a sample, a particle source arranged for producing a primary beam of first electrically charged particles along an optical axis for irradiating said sample, a first detector having an aperture and arranged for ~~amplifying and~~ detecting electron signals ~~emanating~~ originating from the sample due to said irradiation, a detection space formed by at least said sample holder and said first detector, and an immersion lens arranged for providing a magnetic field for focusing the primary beam in the vicinity of the sample holder, wherein said first detector is arranged for providing an electric field in the detection space, and wherein the detection space ~~is arranged for comprising containing~~ includes a gas, said first detector and said immersion lens arranged for providing the electric field and the magnetic field such that the detection space comprises a first portion in which the electric field includes a component ("E") that is oriented transverse to the magnetic field ("B") and in which 2*m*(E/B)^2/q is greater than the ionization energy of the gas, where "m" is the mass of an electron and "q" is the charge of an electron, the apparatus operating in an amplification domain that provides magnetron enhanced amplification of an electron signal from the sample.

2. (original) Particle-optical apparatus according to claim 1, wherein said first detector and said immersion lens are further arranged for providing the electric field and the magnetic field such that the detection space comprises a second portion in which the electric field and the magnetic field are parallel.

3. (currently amended) Particle-optical apparatus according to claim 1, wherein said first detector comprise a first electrode arranged for providing the electric field and for detecting said electron signals, and wherein the ~~first electrode~~ aperture comprises a central opening which is symmetrically formed around the optical axis.

4. (currently amended) Particle-optical apparatus according to claim 2, wherein said first detector comprise a first electrode arranged for providing the electric field and for detecting said electron signals, and wherein the ~~first electrode~~ aperture comprises a central opening which is symmetrically formed around the optical axis.

5. (currently amended) Particle-optical apparatus according to claim 1, further comprising an ion collector arranged to collect ions that are liberated in the gas due to interactions between the gas and said electrons.

6. (original) Particle-optical apparatus according to claim 1, further comprising a second detector arranged for detecting second charged particles, such as ions, that are liberated in the gas due to interactions between the gas and said electrons.

7. (currently amended) Particle-optical apparatus according to claim ~~5~~ 6, wherein the second detector comprises a second electrode, wherein said second electrode is located between the sample and the first detector, and wherein the second electrode comprises a central opening that is symmetrically disposed around the optical axis.

8. (cancelled)

9. (original) Particle-optical apparatus according to claim 1, wherein the sample holder comprises a third detector.

10. (currently amended) Particle-optical apparatus according to claim 1, further comprising a ~~fourth~~ detector arranged for detecting photons formed as a result of interactions between the gas and said electrons.

11. (original) Particle-optical apparatus according to claim 1, further comprising means arranged for electrically biasing the sample in order to influence said field in said detection space.

12. (original) Particle-optical apparatus according to claim 1, further comprising a plurality of further detectors arranged for detecting charged particles and for providing signals on the basis of said detecting, and means for providing an output signal that is composed of a combination of at least two signals provided by any one or more of said plurality of further detectors and said first detector.

13. (cancelled)

14. (cancelled)

15. (original) Particle-optical apparatus according to claim 2 in which the transverse component of the electric field is such that the apparatus operates in an amplification domain that provides combined magnetic Penning enhanced amplification and magnetron enhanced amplification.

16. (currently amended) Particle-optical apparatus according to claim 1 in which the ~~transverse component of the electric field is such that the~~ apparatus provides a gas amplification ~~is~~ greater than ~~2000~~ 1000 at an anode voltage of less than 400 V.

17. (currently amended) Particle-optical apparatus according to claim 1 in which the ~~transverse component of the electric field is such that the~~ apparatus provides a gas amplification ~~is~~ greater than 5000.

18. (currently amended) Particle-optical apparatus according to claim 1 in which the ~~transverse component of the electric field is such that~~ the apparatus provides a gas amplification ~~is~~ greater than 10000.

19. (currently amended) A detector comprising a ring-shaped electrode and an amplifier, for use as first detector in a particle-optical apparatus comprising a sample holder arranged for receiving a sample, a particle source arranged for producing a primary beam of first electrically charged particles along an optical axis for irradiating said sample, ~~said first detector,~~ a detection space formed by at least said sample holder and said first detector, and an immersion lens arranged for providing a magnetic field for focusing the primary beam in the vicinity of the sample holder, wherein said first detector ~~are~~ is arranged for providing an electric field in the detection space and for detecting ~~electrons such as secondary electrons emanating~~ an electron signal originating from the sample due to said irradiation, and wherein the detection space is arranged for comprising a gas for amplifying electrons emanating from the sample, said first detector and said immersion lens arranged for providing the electric field and the magnetic field such that the detection space comprises a first portion in which ~~the~~ a component ("E") of electric field is oriented transverse to the magnetic field ("B") and such that 2*m*(E/B)^2/q is greater than the ionization energy of the gas, where "m" is the mass of an electron and "q" is the charge of an electron, the apparatus operating in an amplification domain that provides magnetron enhanced amplification of an electron signal from the sample~~-~~.

20. (currently amended) Method of detecting electron signals in a particle-optical apparatus wherein a sample is irradiated by a primary beam of charged particles and secondary electrons are liberated from said sample by said irradiation, wherein said secondary electrons are accelerated towards a detector and a detection space is at least formed by said detector and said

sample, said detection space comprising a gas <u>that is ionized by the secondary particles to amplify the secondary particle signal</u>, and wherein an immersion lens provides a magnetic field in said detection space, said electric field and said magnetic field provided such that the detection space comprises at least a portion wherein <u>a component ("E") of</u> the electric field is oriented transverse to the magnetic field <u>("B") and wherein 2*m*(E/B)^2/q is greater than the ionization energy of the gas, where "m" is the mass of an electron and "q" is the charge of an electron, the apparatus operating in an amplification domain that provides magnetron enhanced amplification of an electron signal from the sample.</u>

21. (new) The method of claim 20 in which the detection space comprises at least a portion wherein the electric field includes a component parallel to the magnetic field to enhanced gas amplification using a Penning effect.

22. (new) The method of claim 20 in which the electric and magnetic fields produce electron motion such that at least some secondary or daughter electrons will not impact the electrode before colliding with gas molecules.

23. (new) Particle-optical apparatus according to claim 1 in which the electric field includes a component that is substantially radially oriented within the aperture.

24. (new) Particle-optical apparatus according to claim 2 in which the electric field includes a substantially radial component within a region inside the aperture and includes a component substantially parallel to the optical axis within a region above and below the aperture.

25. (new) Particle-optical apparatus according to claim 1, wherein said first detector comprise a first electrode arranged for providing the electric field and for detecting said electron signals, and wherein substantial electrons from the sample and daughter electrons maintain cycloidal motion within the detector space without contacting the first electrode until losing

energy in collisions with gas molecules, thereby increasing gas amplification particularly at low gas pressures.

26. (new) A particle-optical apparatus, comprising:

a particle source arranged for producing a primary beam of electrically charged particles and directing the primary beam along an optical axis for irradiating a sample;

a first detector arranged for detecting electron signals emanating from the sample due to said irradiation and amplified by a gas;

an amplification space including a gas for ionization and comprising a first region including a magnetic field and an electric field having a component "E" transverse to the magnetic field such that 2*m*(E/B)^2/q is greater than the ionization energy of the gas, where m is the mass of an electron, "q" is the charge of an electron and "B" is the axial component of the magnetic field, and in which the amplification space further comprises a second region in which the electric field includes a component parallel to the magnetic field, the apparatus proving gas amplification through a combination of Penning and magnetron effects.

27. (new) The apparatus of claim 26 further comprising a magnetic immersion lens having a first pole positioned between the sample and the particle source to provide the magnetic field and in which:

the first detector includes an electrode positioned between the sample and the first pole and having an aperture; and

the amplification space being positioned between the sample and the first pole, the magnetic immersion lens providing within the aperture the magnetic field and the electrode providing the electric field.

28. (new) The apparatus of claim 27 in which the electrode is maintained at a positive electrical potential relative to the sample and to the first pole to provide the electric field.

29. (new) The particle-optical apparatus of claim 27 in which the gas amplification is greater than 1000 at an anode voltage of less than 400 V.

30. (new) A particle-optical apparatus, comprising:

a particle source arranged for producing a primary beam of electrically charged particles and directing the primary beam along an optical axis for irradiating a sample;

a magnetic immersion lens having a first pole positioned between the sample and the particle source;

a first detector arranged for detecting electron signals emanating from the sample due to said irradiation and amplified by a gas, the first detector having an aperture and being maintained at a positive electrical potential relative to the sample and to the first pole;

an amplification space between the sample and the first pole, the amplification space including a gas for ionization, the magnetic immersion lens providing within the aperture a magnetic field, the detector providing an substantially radially directed electric field within a region of the aperture and providing an electric field having a component parallel to the magnetic field in a second region, the combination of the electric fields and magnetic field providing a gas amplification of greater than 500 at an anode voltage of less than 350 V.

31. (new) The particle-optical apparatus of claim 30 in which the gas amplification is greater than 1000 at an anode voltage of less than 400 V.